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MISSISSIPPI RIVER: STUDY OF ALTERNATIVES FOR
REHABILITATION OF LOCK AND D. (U) CORPS OF ENGINEERS ST
PAUL MN ST PAUL DISTRICT APR 76

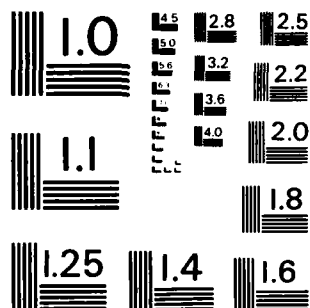
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) It is recommended that both the landward lock, the riverward lock and the dam at Lock & Dam no. 1, Minneapolis, Minnesota be completely rehabilitated. Based on studies completed to the date of this report, more detailed studies are required to firmly establish cost estimates, environmental effects, and the construction scheduling necessary to insure the work can be completed in the proposed two year construction period without delaying navigation.		

DEPARTMENT OF THE ARMY
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MISSISSIPPI RIVER
STUDY OF ALTERNATIVES FOR REHABILITATION OF LOCK AND DAM NO. 1
MINNEAPOLIS, MINNESOTA



SUPPORTING DATA
FOR
APPENDIX H
MECHANICAL INVESTIGATIONS

TABLE OF CONTENTS:

<u>Chapter</u>	<u>Page</u>
(1) Itemized	
I SUPPORTING COSTS	
A Itemized Miter Gate Repair Costs	H-1
B Itemized Miter Gate Operator Costs	H-6
C Itemized Slide Valve Costs	H-7
D Itemized Valve Bulkhead Costs	H-9
E Itemized Lock Bulkhead Costs	H-10
F Itemized Mooring Provisions and Miscellaneous Mechanical Costs	H-12
G Itemized De-icing System Cost	H-16
H Itemized Costs for Station Services	H-17
I Itemized Costs for Temporary River Lock Repairs	H-
II FLOATING MOORING BITT SKETCHES	H-20
III AIR COMPRESSOR SIZING	H-23
IV SOURCES OF DATA AND INFORMATION	H-25

I. SUPPORTING COSTS

The cost figures below can be found summarized in Chapter X of Appendix H.

A. Itemized Miter Gate Repair Costs

H) 1. Miter Gate Labor Costs (Item 1-A, Chapter X, of Appendix H)

a. Lower Gates

1951 Feb.-March Construction Labor Costs - \$32,105

ENR Minneapolis Index for common labor:

1950 December - 38

1974 March - 180

1975 January (est.) - 187

Present cost = $\frac{187}{38} \times 32,105 = \$160,000$ (2 sets)

Present cost = $\$160,000 \times 1/2 = \$80,000$ (1 set)

b. Upper Gates

Estimate that half of the cost determined for the lower gates is fixed and the other half of the cost is a function of the size of the gate.

Cost of 1 set = $[0.50 + (0.50) (70,660/173,000)] (80,000) =$
 $= 40,000 + 16,300 = \$56,000$

Where: 70,660 is weight of upper gate in lbs.

173,000 is weight of lower gate in lbs.

c. Total

Total labor cost of combined upper and lower gate

repairs = $80,000 + 56,000 = \$136,000$.

2. Miter Gate Temporary Material Costs (Item 1-B)

a. Lower Gate

1950 December Material Costs - \$13,550

ENR Minneapolis Index for construction material:

1950 December	-	83
1974 March	-	160
1975 January (est.)		175

Present cost = $\frac{175}{83} \times \$13,550 = \$29,000$, say \$30,000
This cost is chosen as the cost of reparations to one set of leaves. Originally, the 1951 repair history gave the \$13,550 cost as that for 2 sets of leaves. However, the lower gates were not repaired simultaneously as required by the current construction schedule but one at a time. Therefore, the cost of material for one set of lower miter gates is the adjusted 1951 cost of both sets of lower gates.

b. Upper Gate

Estimate 80% of lower miter gate costs for upper gates. Cost of 1 set = $(0.80)(30,000) = \$24,000$.

c. Total

Total temporary material costs of combined upper and lower gate repairs = $\$24,000 + \$30,000 = \$54,000$.

3. Miter Gate Equipment Rental Costs (Item 1-C)

a. Lower Gate

1950 Equipment Rental Costs - \$5,400

ENR Minneapolis Index for construction costs:

1950 December	49
1974 March	- 170
1975 January (est.)	- 175

Present cost = $\frac{175}{49} \times \$5,400 = \$19,300$ (2 sets), say \$20,000

Present cost = $\$20,000 \times 1/2 = \$10,000$ (1 set)

b. Upper Gate

Estimate 50% of lower miter gate costs for upper gates.

Cost of 1 set = $(0.50) \times (\$10,000) = \$5,000$.

c. Total

Total rental costs of combined upper and lower gate repairs = $\$10,000 + \$5,000 = \$15,000$.

4. Lubrite Pintle Bushings (Item 1-D)

From Corps of Engineers Drawing No. M-L1-21/27. The existing pintle bushing weighs 174 lbs each. "Lubrite" bushing estimated January, 1975, cost per pound: \$12.00/lb. Cost for each pintle bushing: $(\$12/\text{lb}) (174 \text{ lbs/ea.}) = \$2,088$, say \$2,100/ea.

5. Lubrite Anchorage Bar Bushings (Item 1-E)

From Corps of Engineers Drawing No. M-L1-20/31. The existing bronze bushing weighs 7.1 lbs. Use 8 lbs. Cost for each anchorage bar bushing = $(\$12/\text{lb}) (8 \text{ lbs/ea.}) = \$96/\text{ea.}$, say \$100/ea.

6. Diagonal Extensions (Item 1-F)

Estimated weight of extension (see Plate H-3) = 160 lbs. Estimated cost per pound of structural steel, bars and threaded rod (incl. labor) = \$1.75/lb. Cost per diagonal extension = $(160 \text{ lb/ea.}) (\$1.75/\text{lb}) = \$280/\text{each}$.

7. Diagonal Jacking Bracket (Item 1-G)

Estimated weight of jacking bracket = 175 lbs/ea. Estimated cost per pound of structural steel plate (including labor) = \$2.00/lb.

Cost per bracket = $(175 \text{ lbs/ea.}) (\$2.00/\text{lb}) = \$350/\text{ea.}$

8. Timber Fenders (Item 1-H)

Each timber fender measures 8" x 10" x 30'. Estimated cost per foot of timber is \$5/ft. Cost of each timber fender = $(\$5/\text{ft}) (30'/\text{fender}) = \$150/\text{each}$.

9. Painting (Item 1-I)

a. Upper gate surface area:

As per Corps of Engineers drawing
122 M-L1-21/25, total accessible
surface area (estimated) = 4,500 sq.ft.ea.

b. Lower gate surface area:

By comparison lower to upper gate
height $\frac{53'}{23'} = 2.3$ to 1 ratio (both
about 30' wide x 2'-6" thick).
Surface area for lower gate is:

$$4,500 \text{ sq.ft.} \times 2.3 = 10,350 \text{ sq.ft.}$$

Additional surface area for lower
gates (Note the closer beam
spacing at bottom of lower gate
leaves) = 1,250 sq.ft.

Total accessible surface of
lower gate leaf (estimated) = 11,600 sq.ft.ea.

c. Summary of surface area per lock

Total surface area= 2 x upper gates + 2 x lower
gates= 2 x 4,500 (upper gate) + 2 x 11,600 (lower
gate) = 32,200 sq.ft., say 33,000 sq.ft.

d. Cost estimate:

Sandblast upper and lower gates to bare metal.
Paint per Corps of Engineers (Don Boneville by
phone 10-30-74):

3 coats vinyl base - white, gray, white
3 mills total

3 coats vinyl aluminium
3 mills total

Estimated cost of sandblasting an irregular surface
is \$1.25/sq.ft.

Estimated cost of painting, six coats at \$0.25 per coat per square foot is \$1.50/sq.ft.

Total cost per square foot for sandblasting and painting = \$1.25 + \$1.50 = \$2.75/sq.ft.

Estimated cost of scaffolding per sq.ft.: \$1.00/sq.ft.

Combined cost per square foot for sandblasting, painting and scaffolding = \$2.75 + \$1.00 = \$3.75/sq.ft.

e. Total cost of sandblasting, painting, and scaffolding = (\$3.75/sq.ft.) (33,000 sq.ft./lock) = \$124,000, say \$125,000.

10. Reinforcing Embedded Gate Anchorages for Lower Miter Gates (Item 1-J)

Estimated Weight: \$1,500 lbs/lock
Estimated Cost: \$3.00/lbs (installed)
\$4,500/lock

11. Miter Gate Guides (Item 1-K)

Engineering Estimate: \$3,000/gate

12. Allowances for Labor and Material for Straightening Gate Bottom and Rivet Replacement (Item 1-L)

Engineering estimate:

\$5,000 for 2 upstream leaves

\$15,000 for 2 downstream leaves

\$20,000 total per lock

13. Miter Gate Bolt-Back System (Item 1-M)

Estimated Cost by Corps of Engineers: \$750/lock

14. Ice Protection Plating (Item 1-N)

a. Lower Miter Gates

Estimated weight of aluminum plate per leaf = 996 lbs/leaf.

Cost per gate = (2 leaves) (996 lbs/leaf) (\$4.00/lb)

= \$7,963, say \$8,000.

Estimated volume of foam per leaf = $1280 \text{ ft}^3/\text{leaf}$.

Cost per gate = (2 leaves) ($1280 \text{ ft}^3/\text{leaf}$) ($\$3.40/\text{ft}^3$)
= \$8,700.

b. Total

Aluminum plate:	\$8,000
Foam:	<u>\$8,700</u>
Total estimated Cost	\$16,700

B. Itemized Miter Gate Operator Costs

1. Cylinder Assembly (Item 2-A, Chapter X)

7" bore, 5" rod, 106" stroke similar to Parker Hannifin
DD-NS-23 with gimble mounting base:

Estimated weight	1500 lbs each
Estimated Cost/lb	2.65
Estimated Cost/Cylinder	\$4,000 each

2. Hydraulic Pump Unit (Item 2-B)

a. Pump

Variable discharge 5% - 100%; 3100 cipm @ 1100 psi
max. 1500 psi, Oilgear type DE with reservoir,
motor base:

Estimated Cost	\$3,500
----------------	---------

b. Motor

15 hp, 1200 rpm:

Estimated Cost	750
----------------	-----

c. Estimated additional miscellaneous materials
cost: 750

d. Estimated total pump unit cost: \$5,000

3. Limit Switch Assembly (Item 2-C)

Limitorque type rotary limit switch assy. \$1,000 ea.

4. Latch (Item 2-D)

a. Assembly

Estimated weight 100 lbs
Estimated cost per pound \$2.50
Estimated cost/assembly \$250

b. Cylinder

2" stroke, 2" bore, 1500 psi similar to
Carter Controls Model GNM:
Estimated cost/cylinder \$100

c. Total Latch Assembly \$350 ea.

5. Existing Operator Removal (Item 2-E)

\$18/hr/man x 8 hr/day = \$144/man/day Assume: 4 man
crew, 8 days for installation. Estimated cost of one
operator removal = (144)(4)(8) = \$4,600/each operator.

6. Installation and Testing of New Operator (Item 2-F)

Assume:

\$20/hr/man x 8 hr/day = \$160/man-day

Assume 4 man crew, two weeks for installation. Estimated
cost of installation of one operator = (\$160)(4)(10) =
\$6,400/each operator.

C. Itemized Slide Valve Costs

1. Gate (Items 3-A, 4-A)

Estimated weight of gate - 7000 lbs/ea.
Estimated cost per pound - \$2.00/lb
Estimated cost of gate = (7000 lbs)(\$2.00/lb)
= \$14,000 each gate

2. Hoist Cylinders (Items 3-B, 4-B)

Hydraulic cylinder: 7" bore, 3" piston rod,
120" stroke, design pressure 1400 psi.

Estimated weight of cylinder - 1700 lbs/ea.

Estimated cost per pound - \$2.65/lb

Estimated cost of cylinder = (1700 lbs)(\$2.65/lb)

= \$4,500/cylinder

3. Hydraulic Pump Units (Items 3-C, 4-C)

Variable discharge 5%-100%; 3500 cipm @ 1700 psi
max. 2000 psi, Oilgear type DE with res air,
motor base:

Estimated Cost = \$5,000 each.

4. Limit Switch Assembly (Items 3-D, 4-D)

Limiter torque type rotary limit switch
assembly - \$1,000/each.

5. Motor (Items 3-E, 4-E)

(1) Motor 20 hp, 1200 rpm:

Estimated cost = \$1,500/ea.

(2) Mounting base and miscellaneous equipment:

Estimated cost = \$500/ea.

Total cost \$2,000/ea.

6. Embedded Parts for Filling Valves (Item 3-F)

Estimated weights:

(1) Guides = (2 slots)(50 feet/slot)(24 lbs/foot)

= 2400 lbs

(2) Tracks = (2 slots)(20 feet/slot)(65 lbs/foot)

= 2600 lbs

(3) Sill plate = (10 feet)(36 lbs/foot) = 360 lbs

(4) Lintel plate = (10 feet)(50 lbs/foot) = 500 lbs

Total estimated weight of embedded parts = 5860 lbs

Say 6000 lbs/gate

Estimated cost per pound: \$2.00/lb installed
Estimated cost for filling valve embedded parts
= (6,000 lbs) x (\$2.00/lb) = \$12,000/slot

7. Embedded Parts for Emptying Valves (Item 4-F)

Estimated weights:

(1) Guides	2,500 lbs
(2) Slots	5,500 lbs
(3) Sill	360 lbs
(4) Lintel	<u>500 lbs</u>

Total estimated weight of
embedded parts: 8,860 lbs

Say 9,000 lbs

Estimated cost per pound: \$2.00/lb installed.
Estimated cost for emptying valve embedded parts
= (9,000 lbs) x (\$2.00/lb) = \$18,000/slot

D. Itemized Valve Bulkhead Costs

1. Bulkhead Assembly (Item 5)

Estimated weight of one section of one bulkhead:	725
lbs Estimated weight of 4 sections:	2,900
lbs Estimated weight of bolts & misc. parts:	<u>100 lbs</u>

Estimated weight for one bulkhead: 3,000 lbs

Estimated cost: \$1.50/lb

Estimated cost per bulkhead = (3,000 lbs)(\$1.50/lb)
= \$4,500 each

2. Valve Bulkhead Embedded Parts (Items 6-A, 6-B)

a. Upstream filling valve bulkhead slot (2 required per lock)

Sill beam: length 9.33 feet of W4x13
(13#/ft) = 121 lbs

Side guide Ls; length 2H = 48' of
3x3x1/2 (9.4#/ft) = 451 lbs

Roof seal Ls; length 9.33' of 3x3x1/2 = 87 lbs

Guide seating Ls; length $\frac{12+2}{2 \times 2} = 14'$ of
3x3x1/2 = 132 lbs

Guide seating plates; 14 PL (1 1/2x4x1/2)
(490#/ft³) = $\frac{12 \text{ lbs}}{803 \text{ lbs}}$

Say 800 lbs

Estimated Cost: \$4.00/lb installed

800 lbs x \$4.00/lb = \$3,200/slot

b. All other slots (6 required per lock)

Sill beam; length 9.33 feet of W4x13 = 121 lbs

Side guide Ls¹; length 2H = 102' of
3x3x1/2 = 957 lbs

Roof seal Ls; length 9.33' of
3x3x1/2 = 87 lbs

Guide seating Ls; length $\frac{102.8}{4} =$
30' of 3x3x1/2 = 283 lbs

Guide seating PL; 30 PL (1 1/2x4x1/2) = $\frac{26 \text{ lbs}}{1474 \text{ lbs}}$

Say 1500 lbs

Estimated cost: \$4.00/lb installed

1,500 lbs x \$4.00/lb = \$6,000/each

F. Itemized Lock Bulkhead Costs

1. Bulkhead Sections (Item 7-A)

Estimated Weights:

Structural Steel 7510 lbs each
Low Alloy Structural Steel 4520 lbs each

Estimated total weight: 12,000/lbs/section

Estimated Cost: \$2.00/lb

Cost for one section = (12,000 lbs/section)(\$2.00/lb)
= \$24,000/section

2. Pickup Beam (Item 7-B)

Estimated beam and components weight: 4000 lbs/each

Estimated cost/lb: \$2.00

Estimated cost of pickup beam = (4000 lbs/ea.)(2.00/lb)
= \$8,000/each

3 Bulkhead Trucks (Item 7-C)

Estimated weight of one truck: 750 lbs

Estimated cost per pound of truck: \$1.50/lb

Estimated cost of one truck = (750 lbs/ea.)(1.50/lb)
= \$1.125/ea., say \$1,150/ea.

4. Bulkhead Slot Embedded Parts (Item 8)

Note: Bulkhead slot materials taken from C of E Drawing
No. 89 M-L STA-20/55L1. Upstream bulkhead slots
(weights for 2 slots)

<u>Item</u>	<u>Estimated Weight</u>
L3x3x3/8	316
PL 2x1/4x12	150
PL 4x1/2	300
10WF 33	1533
PL 12x1/2	950
PL 2x1/4x12	95
PL 15x1/2	1430
	4774, say 4800 lbs

Downstream bulkhead slots (weights for 2 slots)

<u>Item</u>	<u>Estimated Weight</u>
L3x3x3/8	770
PL 2x1/4x12	363
PL 4x1/2	728
10WF33	3610
PL 12x1/2	2240
PL 2x1/4x12	211
PL 15x1/2	3160
	11,082, say 11,100 lbs
	15,900

Total estimated weight for 1 lock = 16,000

Estimated cost per pound: \$2.50/lb installed

Cost of one lock = (16,000 lb/lock) (2.50/lb) =
= \$40,000/lock

F. Itemized Mooring Provisions and Miscellaneous Mechanical Costs

1. Floating Mooring Bitt (Item 9-A)

a. Bitt

1959 Bid cost of identical bitt at St. Anthony
Falls - \$4,000.

Estimated material portion: \$1,000

Estimated labor portion: \$3,000

Material Cost Index:

December 1959	-	102
March 1974	-	160
Est. January 1975	-	170

January 1975 Material Cost = $\frac{170}{102} \times 1000 = \$1,700$

Labor Cost Index:

December 1959	-	71
March 1974	-	175
Est. January 1975	-	180

January 1975 Labor Cost = $\frac{180}{71} \times 3000 = \$7,700$

Total estimated cost of each
floating mooring bitt = \$9,400/ea.

b. Guide Sections

From El. 678.0 to El. 731.5 is 53.5 feet.

Number of 8'0" long sections required on each

side = $\frac{53.5}{8} = 6.7$

From C. of E. Dwg. No. 334 M-L STA-33/502. Weight of each guide section: 630 lbs/8'0" section

Total weight = $2 \times 6.7 \times 630 = 8,500$ lbs

Weight of anchors (ea. 10 lbs), 4 per section =
 $13.4 \times 4 \times 10 = 536$ lbs

Estimated weight, total = $8,500 + 536 = 9,036$ lbs
Say 9,000 lbs

Estimated cost per pound = \$2.00/lb installed

Estimated cost of embedded parts = $(\$2.00/\text{lb})(9000 \text{ lbs})$
= \$18,000

c. Total Costs

Bitt \$9,400

Embedded Parts 18,000

TOTAL \$27,400/each floating mooring
bitt installation

2. Traveling Mooring Bitt (Item 9-B)

a. Bitt

From C. of E. Dwg. No. 193 M-5A-33/13.

Weight of bitt:

Structural Steel	300 lbs
Steel Pipe	400 lbs

Estimated Costs:

Per pound of structural steel	\$3.00
Per pound of steel pipe	\$0.75

Estimated cost of travelling mooring bitt:

$(\$3.00)(300) + (\$0.75)(400) = 900 + 300 = \$1,200$

b. Rail

Estimated length of rail = 310'

Estimated weight per yard rail = 175#/yd.

Estimated cost of rail per pound = \$1.00 installed

Cost of rail = $(310') \left(\frac{1 \text{ yard}}{3 \text{ feet}} \right) (175 \text{ lbs/yard}) (\$1.00/\text{lb})$
= \$18,100

c. Hardware

Estimated amount of manufactured mounting hardware is 700 lbs.

Estimated cost per pound of hardware is \$1.50/lb.

Cost of hardware = (700 lbs) (\$1.50/lb) = \$1,200.

d. Total

Total cost of one traveling mooring bitt:

Bitt	\$1,200
Rail	\$18,100
Hardware	<u>\$1,200</u>

\$20,500/each

3. Check Posts (Item 9-C)

From C of E. Dwg. No. 92 M-L STA-20/561.1.

Weight of post: 315 lbs.

Weight of anchors: 60 lbs.

Estimated cost per pound: \$0.70/lb.

Cost of post and anchors = (375) (.70) = \$270/each

From C. of E. Dwg. No. 19 M-L-STA-20/561.1.

Chock weighs 150 lbs/ea.

Estimated cost per pound is \$0.70/lb.

Cost of chock = (150 lbs) (\$0.70/lb) = \$105/ea.

Total cost per set of post, anchors and chock=\$375/ea.

4. Tow Haulage Unit (Item 9-D)

One hydraulic winch with 10,000 pound minimum pull, 100 feet per minute maximum line pull speed, clutch and brakes.

Cost, including installation, profit and overhead:

\$15,500 ea.

One hydraulic power pack, 1700-2000 psig, 40 gallon per minute. Cost, including installation, profit and overhead:

\$5,000 ea.

One 60 hp electric motor. Cost, including
installation, profit and overhead: \$2,000 ea.

Estimated cost of base and storage tank: \$2,000 ea.

Estimated weight of swivel chock taken
from C. of E. Dwg. No. 231 M-L STA-33/1.1:
2000 lbs.

Estimated cost per pound, including labor
and installation: \$2.00/lb.

Estimated cost of one swivel chock =

(2000 lbs/ea) (\$2.00/lb) = \$4,000 ea.

Estimated cost per foot of 1/2 inch
galvanized steel rope: \$2.00/foot

Cost of 250 feet = (250) (2.00) = \$500

Total Estimated Cost \$29,000 each

5. Revolving Jib Crane (Item 9-E)

Corps of Engineers Estimate \$3,000 ea.

6. Boat Davits (Item 9-F)

Corps of Engineers Estimate \$5,000 ea.

7. Portable Gantry Crane (Item 9-G)

Wallace Gantry Model 1-6010101 \$1,629

Gantry accessories 883

4 ton hand-operated chain hoist
with 56 ft lift 1310

TOTAL \$3,822

Say \$3,900

G. Itemized De-icing System Costs

1. Plans 1, 2, and 3

a. Valves and Piping (Item 10-A)

2 1/2 inch copper tube:	\$6,200
2 inch copper tube:	8,300
1 inch copper tube:	6,200
6 inch copper pipe:	600
Assorted valves and nozzles	<u>6,200</u>

Total	\$27,500
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Say	\$28,000
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b. Air Compressor (Item 10-B)

One air-cooled air compressor, 100 cfm capacity and 100 psi discharge pressure each. One to be used for continuous de-icing while the other is in reserve and auxiliary tool use: \$16,000

Note: All costs based on 1974 list prices, including an allowance for price increases, installation, profit and overhead.

2. Plan 4

a. Valves and Piping (Item 10-A)

Valves and piping for one lock (see Section 1a above)	\$28,000
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Additional piping necessary for second lock	<u>\$14,000</u>
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Total	\$42,000
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b. Air Compressor (Item 10-B)

Two air-cooled air compressors
100 CFM, 100 psi: \$16,000/ea.

(2) x (16,000) =	\$32,000
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H. Itemized Costs for Station Services

1. Fire Protection (Item 11-A)

a. Plans 1, 2, and 3

2 pumps with 30 hp motor delivering
500 gpm and 130 feet of head and
pumphouses \$24,000

System comprised of various tubing,
standpipes and strainers, valves,
2 1/2 inch firehoses and reels \$36,000

Electrical control equipment \$5,000

Total \$65,000

b. Plan 4

3 pumps with 30 hp motor delivering
500 gpm and 130 feet of head and
pumphouses \$36,000

System comprised of various tubing,
standpipes and strainers, valves,
2 1/2 inch firehoses and reels \$56,500

Electrical control equipment
(includes controls from each hose
cabinet) \$7,500

Total \$100,000

2. Sanitary Facilities (Item 11-B)

Lavatory, water closet, urinals, water
heater, drinking fountain, and wash
facilities \$2,500

Piping \$1,500

Force main, grinder pump and two lift
stations (Est. from C. of E.) \$40,000

Total \$44,000

3. Heating, Ventilating and Air Conditioning (Item 11-C)

Estimated required air conditioning: 7 tons
Estimated air conditioning system cost: \$2000

Estimated cost of unit = (7 tons) (\$2000/ton) = \$14,000

Estimated heating and ventilating
requirement: 5150 cu.ft. per minute

Estimated cost per cfm: \$2.00 per cfm

Estimated cost of heating, ventilating,
and air conditioning system=
(5150 cfm) (\$2.00/cfm) = \$10,300

Total cost for HV & AC \$24,300

Say \$25,000

I. Itemized Costs for Temporary River Lock Repairs

1. Remove and Replace Stoney Gates

\$18/hr/man x 8 hr/day = \$144/man/day

Estimate: 4 man crew, 12 days required

Estimated cost of 1 gate removed and replaced:
(144) (4) (12) = \$6,900, say \$7,000

2. Allowance for Stoney Gate Replacement Parts

Engineering Estimate: \$10,000 each

3. Remove and Replace Miter Gate Operators

\$18/hr/man x 8 hr/day = \$144/man/day

Estimate: 4 man crew, 6 days required

(144) (6) (4) = \$3,400 each

4. Allowance for Miter Gate Operator Replacement Parts

a. Labor to Rebuild Cylinder

Estimate: 55 man-hours at \$18/hr

Total labor cost: (55) (18) = \$990

b. Parts for Rebuilding Cylinder

2 Packing rings per cylinder at
\$50/ea. = \$100

Piston ring (cast iron)
(1/cylinder) (35 lbs/ea.) (\$2.00/lb) = \$70

Stuffing box pack rings
(9/cylinder) (\$10/ea.) = \$90

Type I cast iron rollers
(4/cylinder) (7 lbs/ea.) (\$2.00/lb) = \$60

Type II cast iron rollers
(5/cylinder) (26 lbs/ea.) (\$2.00/lb) = \$260

Sector arm bushing
(65 lbs/cylinder) (\$7.00/lb) = \$450

Thrust washer
(65 lbs/cylinder) (\$7.00/lb) = \$450

Recondition 4-way valve = \$500

Total Replacement Parts \$2,975

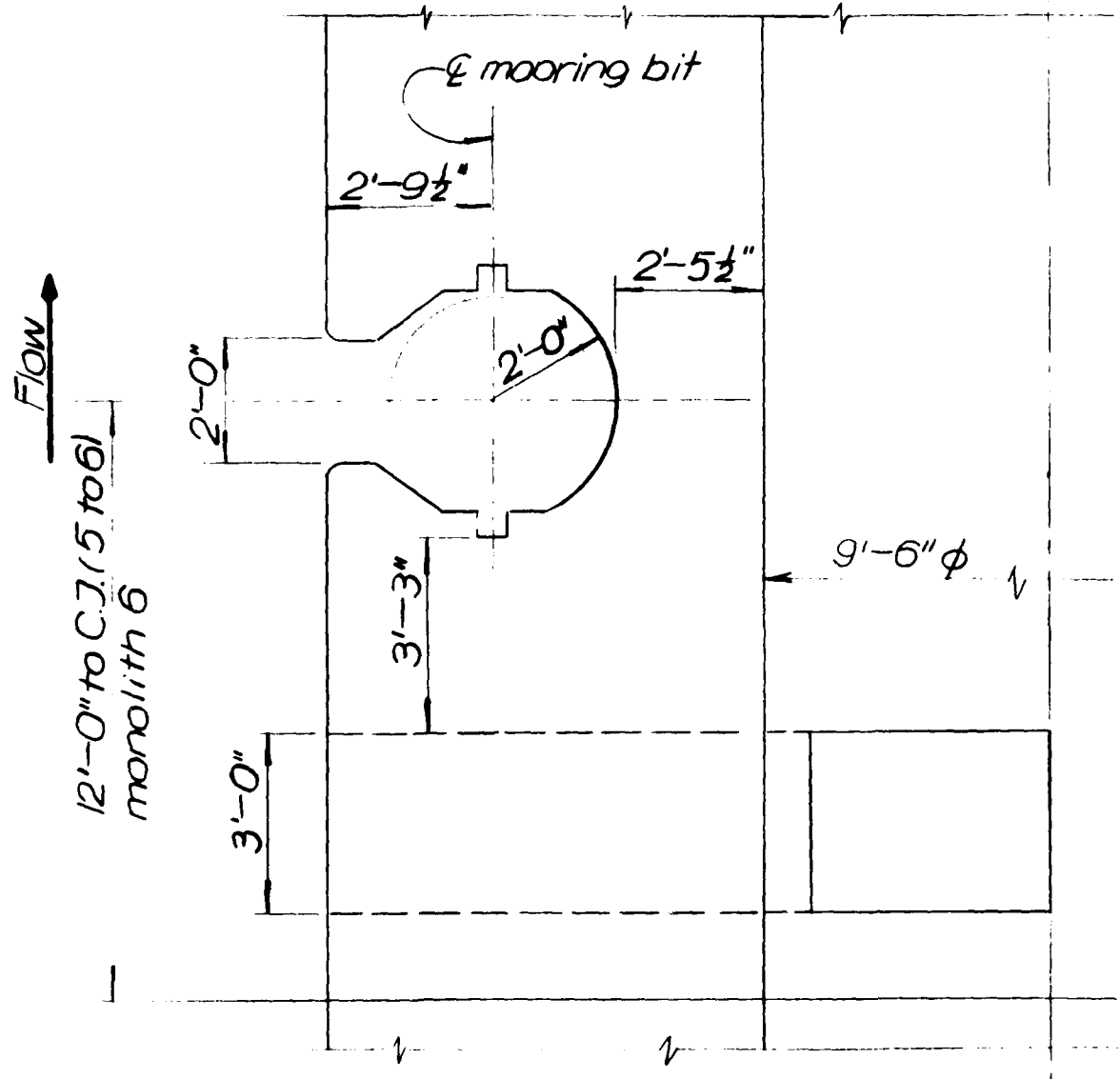
Say \$3,000/ea.

II. FLOATING MOORING BITT SKETCHES

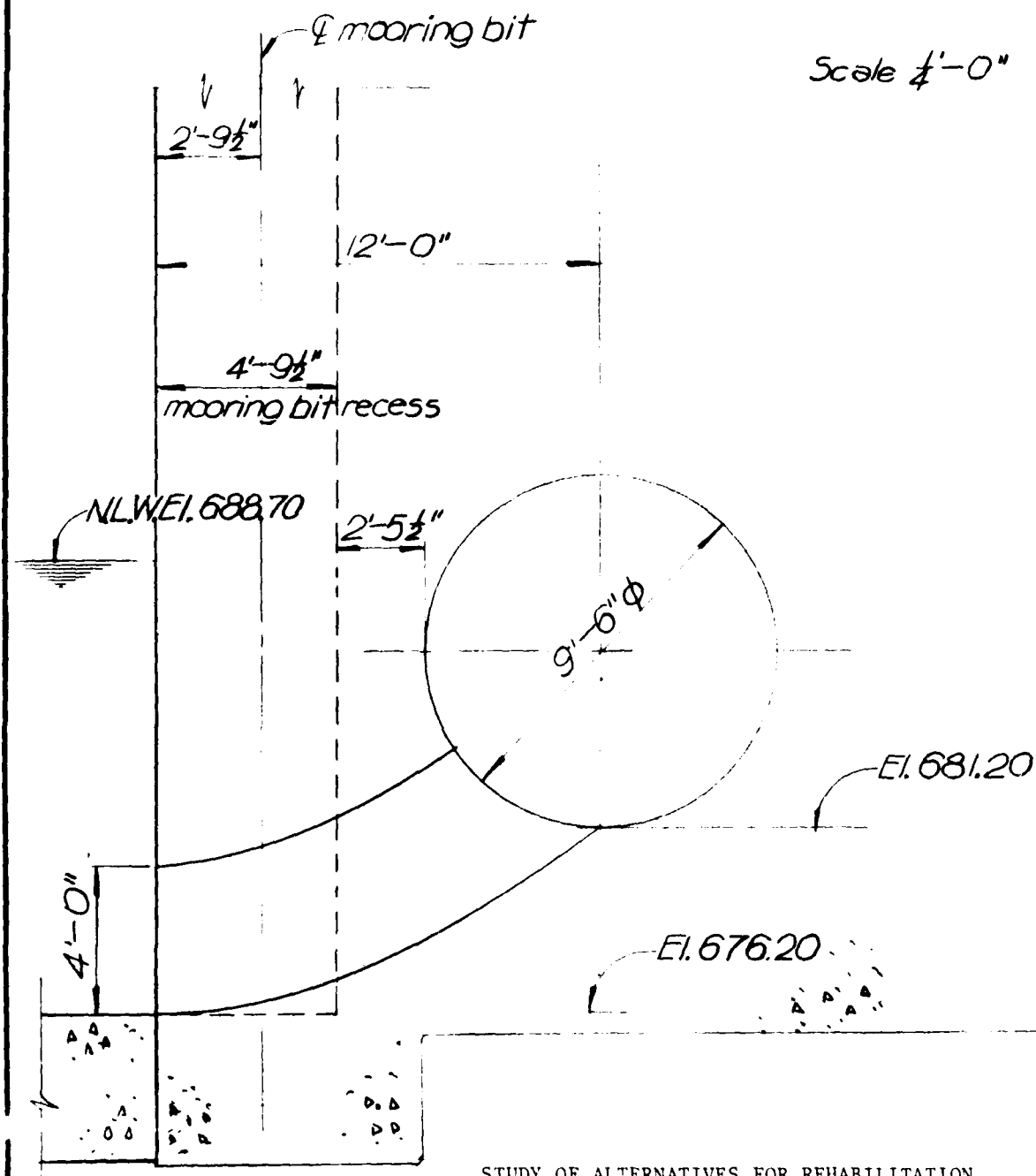
This chapter displays the floating mooring bitt-filling conduit and manifold interactions and clearances.

Sketch 1 - Floating Mooring Bitt - Conduit Manifold, Plan View	Page 21
Sketch 2 - Floating Mooring Bitt - Conduit Section	Page 22

Scale $\frac{3'}{8''} - 0''$



STUDY OF ALTERNATIVES FOR REHABILITATION
MISSISSIPPI RIVER LOCK & DAM NO. 1
MECHANICAL INVESTIGATIONS
FLOATING MOORING BITT CLEARANCES
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III. AIR COMPRESSOR SIZING

The size of the air compressor to be used in the lock de-icing system was determined for Plans 1, 2, and 3 using the following criteria:

- A. Air Pressure: Nozzle discharge pressure will be static head + 2 psi.
- B. Air Quantity: 2 cfm per nozzle.
- C. Nozzle Size: 1/8".
- D. Piping Material:
 - Copper tubing
 - Wrought copper and brass soldered fittings
 - Brass valves
 - Brass pipe and nipples at the control stations and air outlets, where screwed joints are required
 - Pressure reducing valves will be provided at de-icing stations.

E. <u>Air Quantity:</u>	No. of nozzles:
	-Miter gate recesses: 4 x 4 = 16
	-Miter gate (upstream) = 8
	-Quoins 4 x 3 = 12
	-Filling gate recesses 4 x 2 = 8
	44

44 nozzles x 2 cfm = 88 cfm

F. <u>Static Pressure:</u>	Upstream miter gate:
	Top of lock El. 733.0 (Norm. W.L.F. 724.7)
	Bottom of gate El. 709.7
	23.3 ft
	Downstream miter gate:
	Max. water level El. 688.7
	Bottom of gate El. 675.7
	13.0 ft

Assume that filling gate slot nozzles will operate while channel is filled to normal upstream W.L. El. 724.7

Nozzle El.	El.	<u>692.0</u>
		32.7 ft

$$\begin{array}{r} 32 \text{ ft} \times .433 = 14 \text{ psi} \\ + 2 \text{ psi} \\ \hline 16 \text{ psi} \end{array}$$

G. Air Tools:

From Compressed Air Handbook:

Best operating pressure 90 psi; at 60 psi, efficiency is 50% lower.

10 - 1" air outlets will be provided.

II. Compressor:

One air compressor, 100 cfm capacity and 100 psi discharge pressure, will be provided. (One air compressor is enough for de-icing (reduced pressure) or for tools, but not simultaneously.)

Ingersoll-Rand ESV, bore 7x5, maximum discharge pressure 125-100 psi, 108.7 cfm at 90 psi, packaged unit, continuous duty.

IV. SOURCES OF DATA AND INFORMATION

A. As-Built Drawings

- | | | |
|-----|-----------------|---|
| 1. | M-L1 40/36.1 | Sluice gate operating machinery assembly. |
| 2. | M-L1 40/37.1 | Sluice gate operating machinery assembly, details. |
| 3. | M-L1 40/37.1A | Sluice gate operating machinery assembly, modified intake trashracks. |
| 4. | M-L1 40/38 | Sluice gate operating machinery assembly, miscellaneous details. |
| 5. | M-L1 40/39 | Sluice gate operating machinery assembly, gate guides. |
| 6. | M-L1 40/41 | Sluice gate operating machinery assembly, replacement of top side of gate frame and bronze strip. |
| 7. | M-L1 Sta 21/501 | Upper miter gate, outline of leaf and recess. |
| 8. | M-L1 27/1 | Piping. |
| 9. | M-L1 27/2 | Piping. |
| 10. | M-L1 20/78 | Debris and ice removal, bubbler system. |
| 11. | | Lock and Dam 2, landward lock, fire protection facilities, profiles, sections and details. |
| 12. | | Lock and Dam 2, landward lock, fire protection facilities, layout plan. |
| 13. | | Lock and Dam 2, landward lock, fire protection facilities, pumphouse. |

14. Lock and Dam 2, landward lock, fire protection facilities, profiles, sections and details.
15. Lock and Dam 2, landward lock, fire protection facilities, details.
16. M-L Sta 20/121 Lock Masonry.
17. M-L Sta 30/1.1 Steel bulkheads for tainter valves.
18. M-L 5A - 33/5 Traveling mooring bitt.
19. M-5A - 33/13 Revisions to traveling mooring bitt bearings.
20. M-LG-33/4 Traveling Mooring bitt, rail, splice bars and clips.
21. M-L5A-10/17 Traveling mooring bitt.
22. M-L Sta-20/55L1 Lock bulkhead recesses.
23. M-L Sta-22/502 Miter gate operating machinery.
24. M-L Sta-22/503 Miter gate operating machinery.
25. M-L Sta-22/504 Miter gate operating machinery.
26. M-L Sta-22/501 Miter gate operating machinery.
27. M-L Sta-22/509 Miter gate operating machinery.
28. M-L Sta-20/561.1 Miter gate operating machinery.
29. M-L Sta-33/1.1 Tow-haulage equipment, haulage units, cable guide details.
30. M-L Sta-36/501 Air bubbler and de-icing systems.
31. M-L Sta-36/502 Air bubbler and de-icing systems.
32. M-L Sta-36/503 Air bubbler and de-icing systems.
33. M-L Sta-36/504 Air bubbler and de-icing systems.

34.	M-L Sta-36/507	Air bubbler and de-icing systems.
35.	M-L Sta-58/501	Lock bulkhead.
36.	M-L Sta-58/502.1	Lock bulkhead details.
37.	M-L Sta-58/503	Lock bulkhead truck.
38.	M-L Sta-58/504	Lock bulkhead truck details.
39.	M-L Sta-33/501	Floating mooring bitt plan, elevation and section.
40.	M-L Sta-33/502	Floating mooring bitt, miscellaneous details.
41.	M-L Sta-29/601.1	Equipment location.
42.	M-L1-20/3	Handrailing - chocks.
43.	M-L1-20/35	Details of miscellaneous parts.
44.	M-L1-20/70	Operational plan - Dewatering two locks.
45.	M-L1-20/71	Lock rehabilitation - Operational plan.
46.	M-L1-20/72	Lock rehabilitation - Existing conditions plan and section.
47.	M-L1-24/1	Stoney gate valves, operating machinery assembly.
48.	M-L1-24/2	Stoney gate valves, operating machinery assembly.
49.	M-L1-24/3	Stoney gate valves, downstream elevation section.
50.	M-L1-24/4	Stoney gate valves, downstream elevation section.
51.	M-L1-24/5	Fixed metal - upper valves assembly.

52.	M-L1-24/6	Fixed metal - lower valves assembly.
53.	M-L1-24/9	Roller train - Valve stem.
54.	M-L1-24/10	Stoney gate valves - wall castings.
55.	M-L1-24/13	Cylinder plunger - plunger base - fastenings.
56.	M-L1-24/14	Valve seal - lintel castings.
57.	M-L1-24/15	Side water seals.
58.	M-L1-24/16	Shields - rubber strips.
59.	M-L1-24/21	Counterweight - Miscellaneous parts.
60.	M-L1-24/22	Control valve assembly.
61.	M-L1-24/23	Control valve cylinder - plunger - bushing.
62.	M-L1-24/30	Stoney gate valves operating house.
63.	M-L1-24/31	Valve house.
64.	M-L1-24/33	Upper valves - Operating machinery assembly.
65.	M-L1-24/34	Lower valves - Operating machinery assembly.
66.	M-L1-24/35	Downstream elevation section.
67.	M-L1-24/36	Upstream elevation section.
68.	M-L1-24/37	Assembly fixed metal lower valves.
69.	M-L1-24/38	Assembly fixed metal upper valves.
70.	M-L1-24/41	Roller train - valve stem.
71.	M-L1-24/42	Wall castings.
72.	M-L1-24/45	Cylinder - Plunger - plunger base.

73.	M-L1-24/46	Valve seal - Lintel castings.
74.	M-L1-24/47	Side water seals.
75.	M-L1-24/48	Shields - rubbing strips.
76.	M-L1-24/53	Counterweight - miscellaneous parts.
77.	M-L1-24/54	Control valve assembly.
78.	M-L1-24/55	Control valve cylinder plunger - bushing.
79.	M-L1-24/62	Stoney gate valves operating houses.
80.	M-L1-24/63	Stoney gate valve houses.
81.	M-L1-20/16	Lock gate anchorages.
82.	M-L1-20/17	Details gate anchorages.
83.	M-L1-20/18	Miter sill steel-bearing castings locations.
84.	M-L1-20/19	Miter sill steel-bearing castings, details.
85.	M-L1-20/30	Gate anchorage locations.
86.	M-L1-20/31	Gate anchorages - details.
87.	M-L1-20/32	Miter sill steel vertical bearing castings.
88.	M-L1-20/33	Miter sill steel-bearing castings - details,
89.	M-L1-20/84	Modification - upper gate anchorage.
90.	M-L1-21/0	Lock gates - stress sheet.
91.	M-L1-21/1	Reconstruction upper gates.
92.	M-L1-21/2	Lower gate - upper part.

93.	M-L1-21/3	Lower gate - lower part.
94.	M-L1-21/5	Upper pintle castings - miscellaneous parts.
95.	M-L1-21/6	Construction - 2nd lock - upper gates.
96.	M-L1-21/7	Lower gate - upper part.
97.	M-L1-21/8	Lower gate - lower part.
98.	M-L1-21/10	Upper pintle castings - miscellaneous parts.
99.	M-L1-21/11	Lock gates - stress sheet.
100.	M-L1-21/25	Test program metalized surfaces.
101.	M-L1-21/27.11	Miter gate pintle castings.
102.	M-L1-21/28.11	Miter gate anchorage bars - details.
103.	M-L1-21/29	Miter gate repair - jacking bracket.
104.	M-L1-21/30	Operating plan - repair pintle assembly - lower gate.
105.	M-L1-21/31	Repair pintle assembly - lower miter gate.
106.	M-L1-21/32	Miter gate diagonals.
107.	M-L1-21/34	Repair pintle assembly - lower miter gate.
108.	M-L1-21/36	Miter gate diagonals - general layout.
109.	M-L1-21/37	Diagonal connections - details.
110.	M-L1-21/38	Miter gate - prestressing bracket.
111.	M-L1-21/39.1	Jacking brackets miter end - lower gate.
112.	M-L1-21/42	Miter gate anchorage bars - details.

113.	M-L1-22/1	Reconstruction - gate operating machinery assembly.
114.	M-L1-22/2	Sector - sector arm.
115.	M-L1-22/3	Operating strut - miscellaneous machinery.
116.	M-L1-22/4	Operating machinery - cylinder - piston.
117.	M-L1-22/5	Cylinder base - sector base - miscellaneous.
118.	M-L1-22/6	Double 4-way valve - assembly - details.
119.	M-L1-22/7	Double 4-way valve - details.
120.	M-L1-22/9	Operating machinery assembly - 2nd lock.
121.	M-L1-22/10	Operating machinery - sector - sector arm.
122.	M-L1-22/11	Operating strut - miscellaneous parts.
123.	M-L1-22/12	Operating machinery - cylinder - piston.
124.	M-L1-22/13	Cylinder base - sector base.
125.	M-L1-22/14	Operating machinery - double 4-way valve.
126.	M-L1-22/15	Double 4-way valve - details.

B. Construction Photos

1. 113-1/G.9
Black Cover
Construction of original lock
May 1907 - Jan. 1913
28 pictures with periodic construction data and sketches.
2. Construction Photos
Twin City Lock and Dam
Oct. 1929 - Sept. 1930
Black Cover
Approx. 100 pictures.
3. Rehabilitation of Landward Lock
133 photographs
Dec. 16, 1959 - April 4, 1960.

4. Photographs of L/D No. 1 - Brown Cover
June 12, 1973 - Dec. 13, 1973
44 pictures (3 1/2 x 3 1/2).

C. Existing Criteria and Design Manuals

1. Mississippi River
St. Anthony Falls Project
Minneapolis, Minnesota
Design Memorandum No. 3
Upper Lock
Part UL-6 Structural Design
2. Mississippi River
St. Anthony Falls Project
Minneapolis, Minnesota
Design Memorandum No. 3
Upper Lock
Part UL-7 Mechanical Design
3. Manual EM 1110-2-2608 30 Mar. '62
"Engineering and Design"
Navigation Locks - Fire Protection Provisions.

D. Existing Reports and Observations

1. History
Pintle Repair, Diagonal Installation
and
Diagonal Prestressing
Lower Miter Gates Lock and Dam No. 1
1950-51.

E. Reconnaissance Field Trips

The project site was visited by the following engineering personnel of the contractor during the year 1974:

January 21-22	T. G. Szemere	Mechanical
May 13-14	R. L. Pfarr	Mechanical
November 8	R. L. Pfarr	Mechanical
November 8	B. J. Dainis	Mechanical